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ABSTRACT

The CADET Project Modification computer analysis, and both hard copy map-like images and computer tapes are available to the public. A mainframe computer program that permits an Apple microcomputer user to select a particular 40 by 40 pixel sub-scene from a Landsat computer compatible tape and download it to Apple computer diskette via telephone was developed at the University of Oklahoma. Because this mainframe program was designed to operate with United States format Landsat computer tapes, the program was modified to run with Canadian Landsat tapes. In addition, since the U.S. program operates on an IBM mainframe, additional modification was necessary for the program to run on the University of Alberta's Amdahl mainframe. This report discusses the modifications made on both the mainframe and Apple programs and provides information to operate the mainframe program using Canadian Landsat tapes. This information includes: (1) the steps necessary to run the Landsat Digital Image Analysis Program; (2) an example of a complete run; and (3) a list and purpose of files and routines written for the preprocessor package. (JN)

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A SUPPLEMENTARY REPORT

TO THE INNOVATIVE PROJECT FUND,

ALBERTA ADVANCED EDUCATION

OCTOBER 16, 1984

The CADET Project Modification of the University of Oklahoma Mainframe to Apple Landsat Program For Canadian Computer Compatible Landsat Tapes

Landsat satellites continuously monitor the surface of the earth, sending digital data to receiving stations. The data is modified for computer analysis, and both hard copy map like images and computer tapes are available to the public. In Canada, the Prince Albert Satellite Station receives Landsat data and provides it to the public. While analysis of the hard copy images can be undertaken without special equipment, the computer tapes, containing the digital data do require special equipment. State of the art equipment consists of a muni-computer, and elaborate software for extracting and analyzing the data on a monitor. This is too expensive for the average classroom and would ordinarily be found in government funded agencies, specialized university departments, and private industry.

The capability of working with the computer compatible tapes unlocks the full power of Landsat data analysis. The digital data pixels, discrete points on the Landsat images, can be color coded according to their numerical value, and a resulting image can be created on the monitor. Thus, a field of wheat that is stressed by drought, or insect infestation, would have a particular pixel range. By assigning that range a color on the computer, and calling up

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the image, all areas on that image having the same color could be wheat under stress. Animal habitats could also be determined in this manner, as well as certain types of pollution trajectories, water conditions, and man-made features. Ordinarily, a standard Landsat image contains an area 185 km X 185 km with about 7.5×10^5 pixels.

At the University of Oklahoma, Dr. John Harrington and his associates developed a mainframe computer program that permits an Apple microcomputer user to select a particular forty by forty pixel sub-scene from a Landsat computer compatible tape and download it to Apple computer diskette via telephone. The mainframe converts the binary data to text file for downloading, and the University of Oklahoma Apple program repacks the text file into a binary file for analysis. Once in a binary file, the program allows a user to assign colors to pixels in either low or high resolution colors for analysis purposes. In addition, there are several other analysis programs that provide a histogram of the pixel values in each spectral band downloaded, and graph a two point scatter plot of two spectral bands. While not as elaborate as the mini-computer operation, users of Apple computers are now able to undertake extraction and analysis of Landsat data.

There is a difference, though, in pixel shape between the professional systems that analyze Landsat computer data and the Apple program. The former's pixel shape is rectangular, narrow side up, and the latter's is square. This tends to give a slightly squatter shape to the Apple C.R.T. image as compared with the other but does not affect analysis.

A major problem of the Oklahoma mainframe program is that it is designed to operate with U.S. format Landsat computer tapes. The major thrust of the work reported here was the modification of the University of Oklahoma program to run with Canadian Landsat tapes. An additional subsidiary element was that the

mainframe program is also designed for an I.B.M. mainframe, and modification for it to run on the University of Alberta's Amdahl mainframe was also necessary.

Using funds provided by the Innovative Project Fund, a systems analyst was employed to undertake the modifications. After much trial and error, the modifications were successful. The help of the Alberta Remote Sensing Center was of much value, providing both expert advice for the tapes, and materials including format manuals and a loan of a tape with which to make modifications. Dr. Harrington of the University of Oklahoma was also of help, sending a sample tape and microfiche data. Several conference calls were made both with the Remote Sensing Center and Dr. Harrington for the benefit of the systems analyst.

With the use of equipment provided by the Apple Canada Education Foundation, the mainframe program was tested, and the Apple programs modified.

The mainframe program modification included an innovative procedure that by-passed the Apple program procedure. The original University of Oklahoma program has a diskette program that allows the user to select the subscene to be downloaded. In the modification, the selection procedure is done via a program in the mainframe that is self-prompting. The user is prompted for the center line and pixel number of the subscene, then the length and width of the scene. This data can then be saved as a permanent file or destroyed at the conclusion of the download and sign-off. This procedure permits the creation of a file larger than forty by forty pixels from which sub-scenes can be downloaded by others without entering the computer tape. The user is then prompted for the forty by forty pixel subscene, to be downloaded from the new file, also by a request for the center line and pixel. The program then packs binary to text, and the user downloads the text file, using Visiterm communications software.

The user signs-off and repacks the text file to binary in the Apple. Here is where another modification was made to the Oklahoma program. In the original program, if all 1600 pixels were not transmitted, the binary packing program would abort. In the modified program, the text file is examined for its length, and if less than 1600 pixel lines are present, the new program adds sufficient lines of zeros to allow the packing program to operate. Thus, a text file that was partially downloaded because of an interruption can be saved for analysis.

While the mainframe and micro programs are now functional for Canadian Landsat computer compatible tapes some additional modifications are suggested:

1. The binary packing program is in integer basic. It would be speeded up if it was converted to machine language. Presently it takes about an hour to download and pack a text file to binary. The packing is about twenty-eight minutes. It could be reduced to about twelve minutes.

2. The procedure for counting pixels on the computer tape follows a standard procedure outlined by the Canada Center For Remote Sensing. However, the Alberta Remote Sensing Center uses a different program to count the pixels, and there is a discrepancy between the two programs. If an optional program compatible with the Alberta Remote Sensing Center's program can be written for the mainframe it would allow Apple users to call upon the Center to determine pixel locations for center scene downloads. Presently, a user must rough guess a location and download through a trial and error procedure.

Attached to this report is the report of the systems analyst for operating the mainframe program. One addition has been made since the analyst's report was received. The mainframe program has been modified to request the mounting of a specific Landsat computer tape in order to allow multiple tape use. Previous to this, only one tape specially mounted for the program could be utilized.

It is my pleasure to state that to the best of my knowledge and belief, this is the first time that Canadian Landsat tapes have been used with the University of Oklahoma Program developed by Dr. John Harrington and his associates, and that improvements have been made that enhance the original program.

JMK/as
KIRCADET
October 17, 1984

LANDSAT DIGITAL ANALYSIS PACKAGE - OPERATING PROCEDURE

Below is a list of the steps necessary to run the Landsat Digital Image Analysis Package.

STEP 1:

Insert the VISI-TERM diskette into the disk drive and turn on the machine.

STEP 2:

Below is a list of the options that must be specified before the data can be down-loaded to the APPLE.

a) Hit ESC-SHIFT-1 to get into options mode.
b) Set the following options:

```
EOB CHAR     $0A [J]
ACK CHAR     $3E  )
AUTO ACK      NONE
```

c) Hit "F" to get into file transfer mode. Set the following options:

```
FILENAME (this is the destination of the down-loaded data)
PROTOCOL   EOB - ACK
BLOCK CHRS DROP
EOF CHAR   $25  %
```

d) Hit "T" to get back into terminal mode. The options are now in the correct format.

Note: The filename used is the file into which the Landsat data will be put. DO NOT use the filename of an existing file unless it is a text file and you don't need the contents any more. The contents in this file will be over written and will be lost.

STEP 3:

You are now ready to start the Preprocessing stage of the digital image analysis package. At this point you have and option:

a) You may extract a new scene from the CCT (computer compatable tape) and down-load a sub-scene of this to the APPLE
-OR-
b) You may down-load a sub-scene from a previously extracted and saved scene to the APPLE.

Note: To select option "b" you must have previously extracted (option "a") and saved a scene off the data tape. You will be prompted for the name of the saved data so have it ready.

STEP 4:

It is now time to sign on to MTS (Michegan Terminal System). There are two numbers that will connect you to the system, they are: 432-4801 and 432-4811. Once you are connected you will be greeted by MTS and will be asked to identify the terminal that you are working on. The following will appear on your screen:

#Enter terminal id:

Answer this question by typing in the letters "LA36" (don't include the quotes) and hitting return. Now type in the following:

SIGNON CHAT

Hit return. You will be prompted for the pasword for "CHAT". Type in the password and hit return. You are now signed on.

STEP 5:

Note: If you selected option "b" of step 3 then proceed to step 6.

In this step you will be extracting a scene (or picture) from the Landsat data tape. The scene is specified by the element number and scan line number of the pixel in the center of the scene and by the height and width of the scene (the number of pixels high by the number of pixels wide). To start the extraction type in the command:

EXEC STEP1

After the tape is mounted you will be asked to enter the scene center scan line number and element number. Enter these two numbers and hit return. You will then be asked to enter the height and width of the scene. Enter these numbers and hit return. The last prompt will be for the scene title. Type in the name of the scene here and hit return. The extraction of the desired scene will now be carried out.

After the scene has been extracted you will be asked if you wish to save the extracted scene.

- If you answer "NO" then the data will be destroyed after the session is over.

- If you answer "YES" you will be prompted for a file name. Enter a name and hit return. The data will be saved and will be available the next time you sign on.

Note: The data files are large and are costly to save - so they should not be saved unless several sub-scenes are to be downloaded from the same extracted scene. The data files may be destroyed - once created - by the command:

$DELETE [filename]

where [filename] is the name of the file. This command should be given at the beginning of a session.

STEP 6:

In this step the extracted data will be processed and then sent over to the APPLE text file. To begin this step type in the command:

EXEC STEP2

The utility programs will determine the range of scan lines and element numbers in the extracted scene. This information will be printed on you screen. You will then be asked to specify the center of the sub-scene to be downloaded to the APPLE. Enter the scan line number and the element number of the pixel at the center of the sub-scene you desire. Hit return. When the desired sub-scene has been located the following will appear on your screen:

Prepare for data transfer...
(nee nee nee... working...)

At this time you have 60 seconds to get your APPLE ready to receive the data. This should be plenty of time so don't panic. Once the above message appears enter the following:

a) Type ESC-SHIFT-1 to get into options mode.

b) Enter a "F" to get into file transfer mode.

c) Enter a "R" to start receiving the data. If the file already exist then enter a second "R" to cause the file to be replaced.

d) After 60 seconds have elapsed hit RETURN - ONCE. You should now see the data being transferred.

Note: If the data transfer stops before 1600 lines have been sent then hit return again - the stoppages are usually caused by noise on the line and a return should get the data transfer going again.

When all 1600 lines have been transferred drop the line (hang up the phone). The MTS programs will sign you off automatically. The data transfer is now complete.

STEP 7:

Now that the data is in a text file, it can be packed into binary data files. This step is necessary to convert the format of the data into a form usable to the Digital Processing Programs. To do this the following steps should be taken:

a) Insert the "Digital Image Analysis System - Main Programs" diskette into the disk drive and turn the machine on.

b) When the main menu is printed on your screen choose selection number 2 (PACK DATA IN BINARY FILES).

c) When prompted for the "PIXEL EXTRACT FILE" name give it the same file name that you entered in step 2c.

Once the data has been packed into binary files and stored on a diskette you will be ready to proceed to the analysis programs.

SAMPLE RUN OF PREPROCESSING PACKAGE PROGRAMS ON MTS.

In the following two pages, a sample output of one preprocessing run is shown. The underlined portions are the responses of the user.

LANDSAT DIGITAL ANALYSIS PACKAGE

Below is an example of a complete run:

```
#EXEC STEP1

LANDSAT DATA ANALYSIS PACKAGE

University of Alberta  13:08:45  07-09-84

The data tape must be mounted - please wait...

*T*: MOUNTED ON T3C5

Enter scene center pixel scan line
number and element number: 1200 1000

Enter the height and width, in pixels,
of the area to be extracted: 120 40

Enter the scene title:TEST,JULY 9, 1984
 File "COMMANDS" has been created.

Execution begins...


IMAGE DATE                  26JUL82

SCENE ID                    2236717533

PIXEL BOUNDARY               1140          979

PIXEL BOUNDARY               1260          979

PIXEL BOUNDARY               1260         1021

PIXEL BOUNDARY               1140         1021

FILE TITLE                  TEST, JULY 9, 1984

RUN BIP EXTRACT

NOTE: THE UNTRIMED EXTRACTED AREA IS 48X127

NOTE: EXTRACTION COMPLETED

NOTE:    4879 PIXELS EXTRACTED

NOTE: SWICHING I/O FILES, IN=12, OUT=10

NOTE: END OF FILE

STOP    112
```

```
Still executing...


Do you wish to save the extracted data? (yes/no):NO
*T*: T3C5 released

bye...
#EXEC STEP2
# $SET ECHO=OFF

LANDSAT DATA ANALYSIS PACKAGE

University of Alberta  13:11:38  07-09-84

Please wait...


SCAN LINES RANGE FROM  980 TO 1021
ELEMENT NUMBERS RANGE FROM 1141 TO 1260
ENTER SCENE CENTER SCAN LINE AND ELEMENT NUMBER: 1000 1200

Prepare for data transfer...
(nee nee nee... working...)
```

SOFTWARE WRITTEN FOR THE PREPROCESSOR PACKAGE

Below is the list of files and routines written for the Preprocessor Package:

1) File Name: STEP1 (EXEC file)

   Purpose: This file, when EXECuted, causes several utility programs and the Preprocessor Program to be run. The utility programs are necessary to set things up properly for the Preprocessor.

2) File Name: STEP2 (EXEC file)

   Purpose: This file, when EXECuted, causes several utility programs to be run. The last program executed sends the data to the APPLE. The other routines put the data in the correct format.

3) File Name: READER (FORTRAN subroutine)

   Purpose: This routine is call by the Preprocessor Program to read the data off the Canadian format CCT's.

4) File Name: CONVERT (FORTRAN program)

   Purpose: This routine is run in STEP2 and converts the data to be sent into character strings. This is the last step before the data is downloaded.

5) File Name: SENDME (FORTRAN program)

   Purpose: This routine sends the data to the APPLE in EOB-ACK protocol.

6) File Name: RENAME (FORTRAN program)

   Purpose; This routine will create a permanent file in which the extracted data will be stored if the user specifies that the data is to be saved.

7) File Name: CREATE (FORTRAN program)

   Purpose: This routine builds the command file which instructs the Preprocessor Program which pixels to extract.

8) File Name: PICK (FORTRAN program)

   Purpose: This routine scans the extract data for the scan line range and element number range. This information is used by routine GATHER to assemble the desired sub-scene of the extracted data for downloading.

9) File Name: GATHER (FORTRAN program)

Purpose: This routine gathers up the correct pixels from the extracted data and puts them into a separate file. This file will be converted into the correct format and will be downloaded.

MODIFICATIONS MADE TO EXISTING SOFTWARE

Below is a list of the changes made to the existing software (this is the set of programs on the APPLE diskette and the Processing Package program on the magnetic tape).

1) Routine Name: Digital Image Analysis Programs Package

File: Programs are on the APPLE diskette.

Purpose: These programs are used to process the digital data.

Changes: The catalog of programs was corredtec so that the menu choices correspond to the proper routines.

The HELLO program was changed so that Integer Basic is loaded into the language card each time the machine is booted up on this diskette. Integer Basic is used by one of the routines and was not previously available on this diskette.

The user now has the option to run Boomer Sooner or to omit it. If you wish to omit Boomer Sooner, just hit "RETURN" when prompted for a response to the Boomer Sooner question.

2) Routine Name: Preprocessing Program.

File: LS.MAINPR03

Purpose: To extract scenes from Landsat data tapes.

Changes: The EXTRCT routine was changed sot that the preprocessor would use Canadian format Landsat tapes. EXTRCT now calls a routine "READER" which does the actual reading of data on the tape. Some output formats were also changed in the EXTRCT routine.

The PRTMAP routine was modified so that a call to a system subroutine that is not available on MTS does not occur. This routine was called to get the time and date and its omission does not present any problems.